What is a Proportional Symbol Map?

- Depicts spatial variations in value or magnitude
- Using proportionally sized point symbols
- May also convey density of phenomena
Spatial Data Characteristics

- Discrete point data
- Data aggregated by discrete areal unit
- May be used to map sampled values of a continuously distributed phenomenon

Aspatial Data Characteristics

- Can use raw or derived data
  - Dent argues derived values can be used to control range of data values
- Normally, the rule of thumb is:
  - raw values for discrete point features
  - derived for data aggregated by discrete areal unit

When Is It Used?

- Used in two circumstances:
  1. When objective is to show spatial variations in value/magnitude at point locations
     - only choice
  2. For mapping areally discrete data represented at a point
     - other alternatives
Not the best choice when?

1. Range of data values is limited
2. Data provided is normalized, can’t get raw
3. Data are interval level with an arbitrary 0 value or have other zero values

Data Range

**NOTE**: variations in attribute value must be adequately large so that there is significant differences in relative symbol size

Limited variation in symbol size = boring map

Advantages/Disadvantages

**Advantages**:
- ease of interpretation
- ability to portray distribution of multiple phenomena
- ability to portray multiple attributes of phenomena

**Disadvantages**:
- inaccurate perception of symbol size
Considerations: Symbol Selection

- Any point symbol that can be scaled may be used.
- Most common is a solid circle:
  - compact
  - easily scaled
  - visually stable
  - no orientation

Considerations: Symbol Selection

- If more than one distribution is represented:
  - Use same symbol style
  - Vary colour hue, not saturation/value
  - Can also use replicative and carefully scaled symbols

Considerations: Symbol Size

- Area is geometric property scaled, not H or W
- Volume in the case of 3-D symbols
  - more compact
  - greater range can be presented
  - **BUT**, perception of relative value/magnitude is poor
  - only use to represent volumetric quantities
Considerations: Symbol Size

- Map-readers consistently underestimate symbol size
- Error increases with size
- Solutions:
  - Legend Design
  - Range graded symbols
  - Apparent magnitude scaling

Range Graded Version

- Data classed
- Standard symbol sets used
- No longer proportional

Range Graded “Proportional” Symbols
Apparent Magnitude Scaling

Adjusts symbol size to account for misinterpretation
- Based on experimental values – not consistent but improved map interpretation

Determining Symbol Size

1. Select minimum symbol size; still visible
2. Verify maximum symbol size is not too large

To be proportional

\[ \frac{\text{Area}_1}{\text{Area}_2} = \frac{\text{Value}_1}{\text{Value}_2} \]

Determining Absolute Symbol Size

For a circle, area = \( \pi R^2 \) so,

\[ \frac{\pi R_1^2}{\pi R_2^2} = \frac{\text{Value}_1}{\text{Value}_2} \text{ or,} \]

\[ \frac{R_1^2}{R_2^2} = \left(\frac{\text{Value}_1}{\text{Value}_2}\right) \text{ or,} \]

\[ R_1 / R_2 = \left(\frac{\text{Value}_1}{\text{Value}_2}\right)^{1/2} \text{ or,} \]

\[ R_1 / R_2 = \left(\frac{\text{Value}_1}{\text{Value}_2}\right)^{1/2} \]

\[ R_1 = R_2 \left(\frac{\text{Value}_1}{\text{Value}_2}\right)^{1/2} \]
Determining Symbol Size

3. Given minimum symbol size and value calculate all other symbols by:
   - E.g. radius of smallest circle = 1.5 cm
   - Value smallest circle = 200
   - Value other circle = 400

   \[ R_u = R_s \left( \frac{\text{Value}_u}{\text{Value}_s} \right)^{1/2} \]
   \[ R_u = 1.5 \text{ cm} \times \left( \frac{400}{200} \right)^{1/2} \]
   \[ R_u = 2.12 \text{ cm} \]

   Note: Apparent scaling would use exponent value of 0.5716; so \( R_u = 2.23 \text{ cm} \)

Determining Symbol Size

For a square symbol:

\[ S_u = S_s \left( \frac{\text{Value}_u}{\text{Value}_s} \right)^{1/2} \]

Determining Symbol Size

For replicative symbols
   - area should also be scaled proportional
   - Not height
   - Proper legend design is important
Considerations: Multivariate Symbols

- Symbols may be:
  - segmented (pie charts)
  - colour coded
  - and inset (small circles inside of larger circles)

- in an attempt to portray multiple attributes

Considerations: Symbol Overload

- Complex symbols detract from perception of spatial variations in value
- As a rule, no more than 2 or 3 variables represented with one symbol
  - usually a total amount
  - broken down by category

Considerations: Symbol Placement

- Symbols representing AUs should be:
  - located at geographic centre
  - exceptions to avoid overlap/confusion

- Symbols representing discrete point features:
  - located at absolute position
  - not normally adjusted for placement
Symbols Design

- Cut-outs more aesthetically pleasing; but less accurate
- Transparent circles more accurate; but difficult to identify and differentiate
- Symbols should be foreground objects
- Minimal base map info

Considerations: Legend Design

- Three representative symbols best
  - min, max, and median values
- Nested or stacked
  - Stacked easier to interpret
  - Nested more compact
- Note EAs not reporting
  - or true 0 values

Consideration: Map Projection

- Discrete point features or points representing discrete areal units
  - No particular projection may be required
  - Unless intent is convey density of phenomena
    - then _________ projection should be used
- Discrete areal units
  - Then _________ projection should be used